HOSO

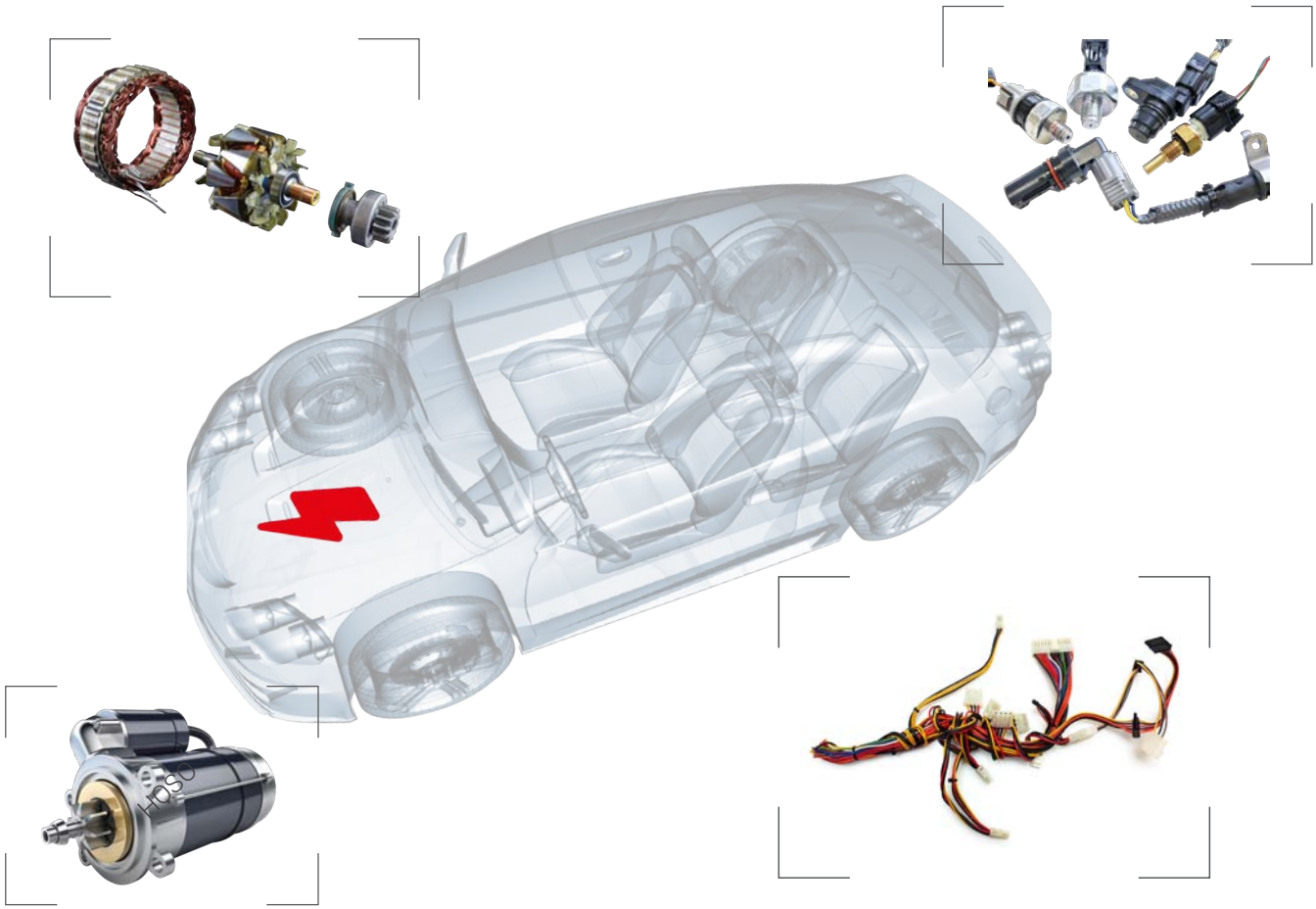
Resistance welding of non-ferrous metals

有色金属电阻焊接电极

随着应用的广泛及深入变化，电阻焊接的工件越来越小型化，并兼具有高导电，高导热的特性，传统的铜电极不再高效适用日益困难的焊接环境。我们需要一种既具有耐高温，又能承受大电流并且耐磨耐烧损的电极。和铄生产的各种铜镶嵌电极具有以上优势，在全自动电阻焊接设备以及场景中得到客户广泛认可。

Resistance welding of non-ferrous metals

The resistance welding of non-ferrous metals, due to their good thermal conductivity and low electrical resistance, places special demands on the electrodes. These features require the use of very high welding currents, so that electrodes made of copper alloys, which do not have adequate hardness and resistance at high temperatures, wear out quickly or are completely unusable.



工件 WORKPIECE	热能评估 HEAT GENERATED	材料特性 MATERIAL PROPERTIES	焊接环境 WELDING CONDITIONS
有色金属 Non-ferrous metals	低 Low amount	电阻低 low electrical resistance 热导率高 high thermal conductivity	大电流 high electrical current 长焊接周期 longer work cycles
黑色金属 Ferrous metals	高 High amount	电阻高 high electrical resistance 热导率低 low thermal conductivity	小电流 low electrical current 短焊接周期 shorter work cycles
铝 Aluminum	低 Low amount	电阻低 low electrical resistance 热导率高 high thermal conductivity	中等电流 middle electrical current 短焊接周期 shorter work cycles

有色金属工件的电阻焊接电极

现在焊接有色金属工件材料主要是用钨钼以及钨合金，钼合金等难熔金属焊头，而电极杆部使用铜合金材料。这主要是因为钨，钼等难熔金属耐高温，耐磨以及产生热量快。而杆部采用铜合金是采用其电导率高，热导率高散热好的特点。 用钨钼及其合金作为焊头的铜镶嵌电极在大多数情况下使用良好。

难熔金属焊头的优势：

- 高硬度以及高温软化温度
- 高电导率
- 高热导率
- 抗粘接性能好
- 不太需要添加焊剂

如上优势极大的带来了焊接工艺的好处。因此焊接良率，焊接效率都得到极大的改善，单个电极的使用寿命也大大的提高。

钨钼电极的应用：

这类电极主要用在汽车电子行业的点焊电极。当然这类电极也广泛用在消费类电子以及设备的焊接上。

Resistance welding electrodes for non-ferrous metals

For resistance welding of non-ferrous metals electrodes are made of tungsten (W), molybdenum (Mo) or other refractory alloys due to much better properties during work in high temperatures. Composite electrodes, where the shank supplies electricity and dissipates the generated heat, and the electrode tip made of W or Mo takes part in the welding process, is a very good choice for most applications.

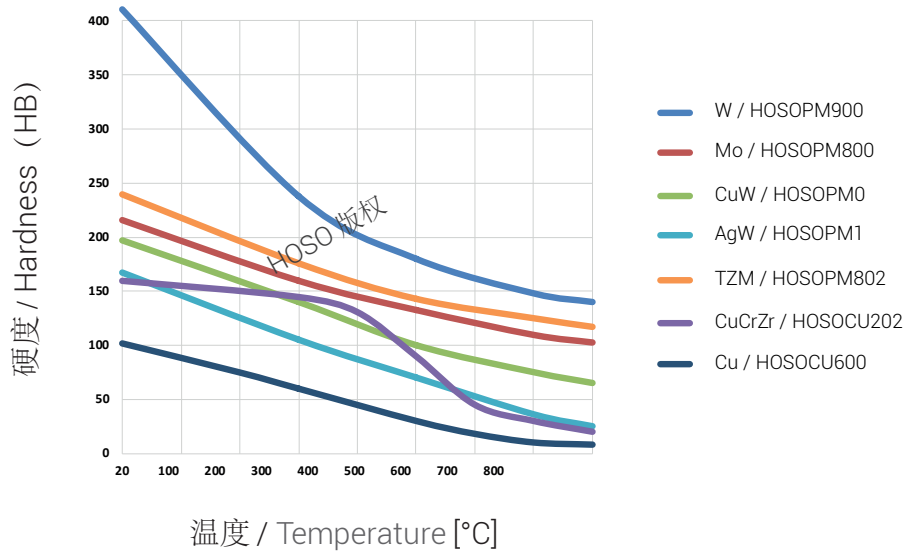
The advantages of refractory metals electrodes:

- stable hardness at high temperatures,
- high electrical resistance,
- low thermal conductivity,
- low adhesion,
- low chemical reactivity with other materials.

The above-mentioned advantages significantly contribute to the stabilization of the welding process, and hence to the improvement of production efficiency and the extension of the life of a single electrode.

The use of tungsten and molybdenum electrodes:

The electrodes are mainly used for welding electrical parts used in the production of cars. Other industries using this type of electrodes include: electronics and household appliances.



各种电极材料在高温下的表现：

上图是各种材料在高温下的硬度变化曲线图。从图中我们知道钨的耐高温性能最好，其实是钼。 这两种材料对比起来钨虽然耐高温性能好但是不好加工， 并且在高温下耐冲击能力不如钼及钼合金。

Hardness of electrode materials at high temperatures

The graph shows the hardness of different materials at high temperatures. The highest hardness regardless of temperature retains tungsten (W). Molybdenum has lower hardness at high temperatures, but in comparison to tungsten it is more resistant to cracks and mechanical and thermal shock.

材料特性

钨 (W)

- 纯度高于99.95%
- 几乎是自然界熔点最高的金属 （3387℃）
- 室温以及升温环境下硬度都很高
- 机械加工塑性不好，易断易碎
- 不与其他金属发生反应
- 电阻大

钼 (Mo)

- 纯度高于99.95%
- 熔点高 （2623℃）
- 机械加工性能好于钨
- 相比钨的硬度以及耐高温性能比较差
- 不宜与其他金属发生反应
- 热导率以及电导率跟钨接近

钨铜合金 (Cu25W75)

- 钨和铜的合金
- 综合了铜跟钨两种金属的性能优点
- 高温下相比其他金属硬度为中等水平
- 比钨钼更高的导电率

银钨合金 (Ag35W65)

- 钨和银的合金
- 跟钨铜相似，在高温下具有中等硬度
- 通常含有35%的银以及65%的钨
- 常用于不锈钢以及镍片的焊接

TZM 合金

- 钛铬钼合金，含量为 0,5%钛,，0,08%铬，99,4%钼
- 高熔点
- 很好的抗腐蚀性
- 比纯钼硬度高
- 很好的热导率以及电导率

Materials properties

Tungsten (W)

- Composed in more than 99.9% pure tungsten.
- The highest melting point among metals (3387°C).
- Very high hardness at both in room and high temperatures.
- Sensitive to mechanical and thermal shock and cracking.
- Low reactivity with other metal components.
- High electrical resistance.

Molybdenum (Mo)

- Composed in more than 99.9% pure molybdenum.
- One of the highest melting point among metals (2623°C).
- More resistant to mechanical and thermal shock than W.
- Less hardness in room and high temperatures compared to W.
- Low reactivity with other metal components.
- Electrical and thermal properties comparable to tungsten.

Copper-tungsten alloy (Cu25W75)

- Alloy made of copper and tungsten.
- Characterized by moderate properties between copper alloys and tungsten.
- Moderate hardness at high temperature.
- Better electrical conductivity than tungsten and molybdenum.

Silver-tungsten alloy (Ag35W65)

- Alloy made of silver and tungsten.
- Like the CuW alloy, AgW is characterized by moderate hardness at high temperatures and electrical conductivity.
- Usually, it consists of 35% Ag and 65% with W.
- Used for welding stainless steel and / or nickel foils.

TZM aloy

- Alloy made of titanium, zirconium and molybdenum (0.5% Ti, 0.08% Zr, and 99.4% Mo).
- High melting point.
- Good chemical corrosion resistance.
- Higher hardness compared to pure molybdenum.
- Good thermal conductivity and electrical resistance.

点焊电极

微点焊因为密度高，能量要求集中所以对电焊电极的要求相当高。 尤其是焊接电极材料中本身必须具有高再结晶温度，高级别的热导率以及电导率，并且在高温下必须有优异的稳定性。

我公司采用高纯度的原料生产的纯钨，纯钼电极不易开裂，刚性高。 点焊寿命长。

钨铜，银钨等合金材料在生产过程中充分考虑塑性跟硬度的参数优化。 我们的材料内部致密在急速升温的情况下能保持稳定的性能。

Micro welding electrodes, special type

Micro resistance welding process of electric conductive materials determine high demands towards the electrodes. Welding electrodes materials have a very high recrystallization temperature, high level of thermal and electrical conductivity while also exhibiting outstanding stability in high temperature. Accelerated degradation of electrode working surfaces due to temperature impact and high force during welding is the most common technological problem affecting stability of the welding process. High-purity refractory electrodes made in powder metallurgy process are excellent for this application.

型号 NAME	材料 MATERIAL	含量 COMPOSITE [%]	密度 DENSITY [g/cm³]	电导率 CONDUCTIVITY [%IACS]	硬度 HARDNESS [HB]	熔点 MELTING POINT [°C]
HOSOCP900	钨 Tungsten	W > 99,95	19,3	30	400–450	3387
HOSOCP800	钼 Molybdenum	Mo > 99,95	10,2	30	195	2623
HOSOCP802	TZM	Mo; Ti-0,5; Zr-0,08	10,1	28	230–250	~ 2500
HOSOCP075	钨铜 Copper tungsten	Cu-25; W-75	14,7	45	195–210	~ 1000

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专属客制化电极/ and other OEM of welding machine

标准尺寸的点焊电极

Spot welding electrodes, standard sizes

我公司的标准尺寸点焊电极参考了国际点焊机厂家的优秀设计，除了焊接电源以外，点焊电极的品质已经成了工件良率提升的关键。我们精益求精，管控生产制作的每一个环节以确保交付最好的产品。

Good respectable quality of welding electrode is very important and key factor of welding yield enhancement. From material to finished parts we control all the step to make sure that we deliver the best quality product to our customers.

材料特性

CP202 (CuCrZr)

适合焊接中碳钢，不锈钢，镍基合金，黄铜等。

Suitable for welding mild steel, stainless steel, Ni base alloys, brass and bronzes.

CP302 (CuCoBe)

适合焊接高合金钢，镍铬合金，蒙乃尔合金。

Suitable for welding high-alloy steel, NiCr-alloys, chromium and monel.

CP202+900 (CuCrZr+W)

钨焊头，杆部是铬锆铜合金。焊接铜线，铜片等。

Composite electrode with tungsten insert for welding non-ferrous metals with high copper content.

Material properties

CP202+922 (CuCrZr+WLa10)

钨镧焊头，杆部是铬锆铜。焊接铜线，铜片等。

Composite electrode with tungsten alloy insert for welding copper and silver, resistance brazing and hot bar welding.

CP202+800 (CuCrZr+Mo)

钼焊头，杆部是铬锆铜。焊接铜线，铜片等。

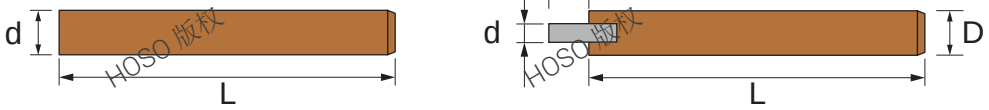
Composite electrode with molybdenum insert for welding copper, copper cable and silver respect and other conductive metals.

CP202+802 (CuCrZr+TZM)

TZM焊头， 杆部 铬锆铜。可焊接铜线，铜片等。

Composite electrode with molybdenum alloy insert for welding copper and compacting device welding and other conductive metals.

电极设计图
ELECTRODE DESIGN



尺寸设计/ DIMENSION			材料/ MATERIAL					
D	d	L	CP202	CP302	CP202+900	CP202+922	CP202+800	CP202+802
3	2	40	–	–	–	–	EM1.C5	–
3	3	40	EM2.C1	EM2.C2	–	–	–	–
4	4	30	EM3.C1	EM3.C2	–	–	–	–
4	4	75	EM4.C1	EM4.C2	–	–	–	–
6	2	50	–	–	EM5.C3	EM5.C4	EM5.C5	EM5.C6
6	3	50	–	–	EM6.C3	EM6.C4	EM6.C5	EM6.C6
6	4	50	–	–	EM7.C3	EM7.C4	EM7.C5	EM7.C6
6	6	50	EM8.C1	EM8.C2	–	–	–	–
10	3	75	–	–	EM9.C3	EM9.C4	EM9.C5	EM9.C6
10	4	75	–	–	EM10.C3	EM10.C4	EM10.C5	EM10.C6
10	6	75	–	–	EM11.C3	EM11.C4	EM11.C5	EM11.C6
10	8	75	–	–	EM12.C3	EM12.C4	EM12.C5	EM12.C6

* 订购码举例/ Order example: **EM2.C1**

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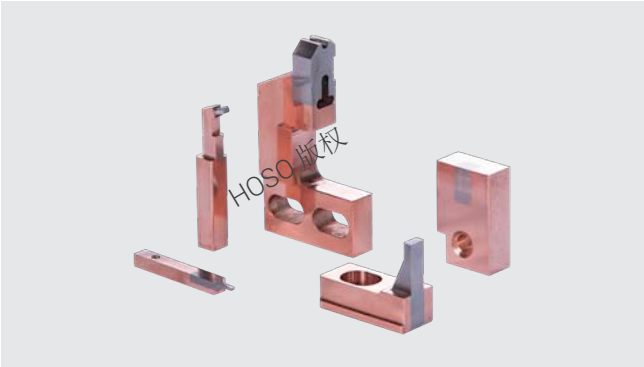
专属客制化电极 / and other OEM of welding machine

铜镶钨钼组合电极

铜镶嵌电极是一种创新式的设计。通过组合不同机械特性（比如硬度，抗拉强度等）以及物理性能（比如电导率，热导率等）的材料的组合。我们可以获得性能优异的焊接电极。

对于这种电极组合方式是非常重要的一环。 和铄根据应用不同独不同组合方式的电极。比如： CBT，BFH，VBH，FGM等适用条件各不相同。

我们知道如何做！



Resistance welding composite electrodes

Composite electrodes are an innovative solution in resistance welding technology. By combining materials with different mechanical properties (hardness, compressive strength, etc.) and physical properties (electrical and thermal conductivity, density) we can achieve electrodes with unique welding parameters. We provide the highest accuracy of machining and a stable joining of materials. Silver braze tip with copper shank.

We know how to do it!

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专属客制化电极 / and other OEM of welding machine

螺柱焊电极

钨铜与铬锆铜组合式电极是和铪专为螺柱焊接独有的设计。HOSOCU®202是我们铬锆铜的牌号，铬锆铜作为高导电的材料最高效率的把电流传导到工件上，并且及时的把工件上产生的热量带走。

电极在不超过350℃的时候必须得到冷却。钨铜（HOSOPM075为含量钨75%铜25%）的钨铜作为与工件接触的焊接面而直接参与焊接。

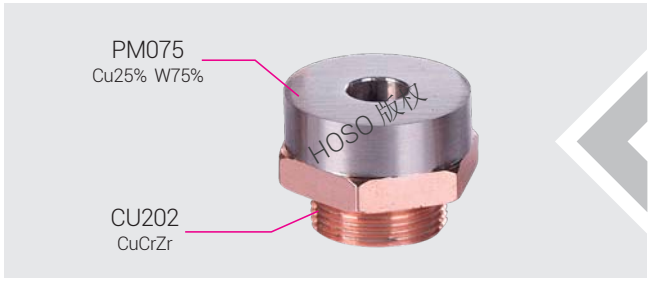
钨铜与铬锆铜电极组合电极具有优良的机械性能， 对应于高导电率条件下的高硬度。因此电极使用寿命长，从而自动化焊接成为可能。

Electrodes for projection welding

An innovative solution of construction of electrode by **combining two materials with different properties**. The HOSOCU202 chromium zirconium copper electrode body is designed to bring current to the working part and dissipate the heat generated in the welding process.

The electrode is cooled and the working temperature in this area does not exceed 350°C. The HOSOPM075 sintered working part is directly involved in the welding process. Good mechanical strength and conductivity as well as hardness at high temperatures are a guarantee of the highest quality.

组合电极 / Composite electrode

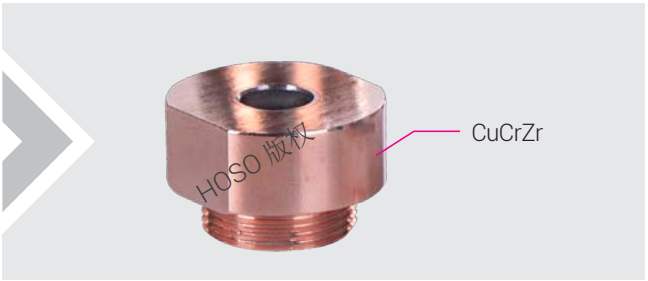


组合式电极远比单纯的铬锆铜，铍钴铜电极更具性价比的优势。基于应用不同，一般而言钨铜组合螺柱焊电极会比普通的铬锆铜电极使用寿命长10多倍。并且电极不含危害物质（铍）符合工人健康使用要求。

这类电极主要应用在：

- 凸焊
- 对焊
- 螺柱焊

普通电极 / Common electrode



Composite electrodes have much better properties than commonly used electrodes made of Beryllium Copper (CuCoBe). Depending on the application, they work from several dozen to several hundred percent longer. The electrodes do not contain harmful beryllium, and their use is safe for employees health.

Application of electrodes:

- projection welding,
- butt welding,
- electrofusion upsetting.

品名 NAME	材料 MATERIAL	含量 COMPOSITE [%]	密度 DENSITY [g/cm³]	电导率 CONDUCTIVITY [%IACS]	硬度 HARDNESS [HB]	软化温度 SOFTENING POINT [°C]
CU202	铬铜铜 CuCrZr	Cr>0,4; Zr>0,03 Cu- balance	8,9	80	160	450
PM075	钨铜 CuW	Cu-25; W-75	14,7	45	220	~ 1000
CU302	铍钴铜 CuCoBe	Co-2,0; Be-0,5	8,8	18	230–250	~ 480

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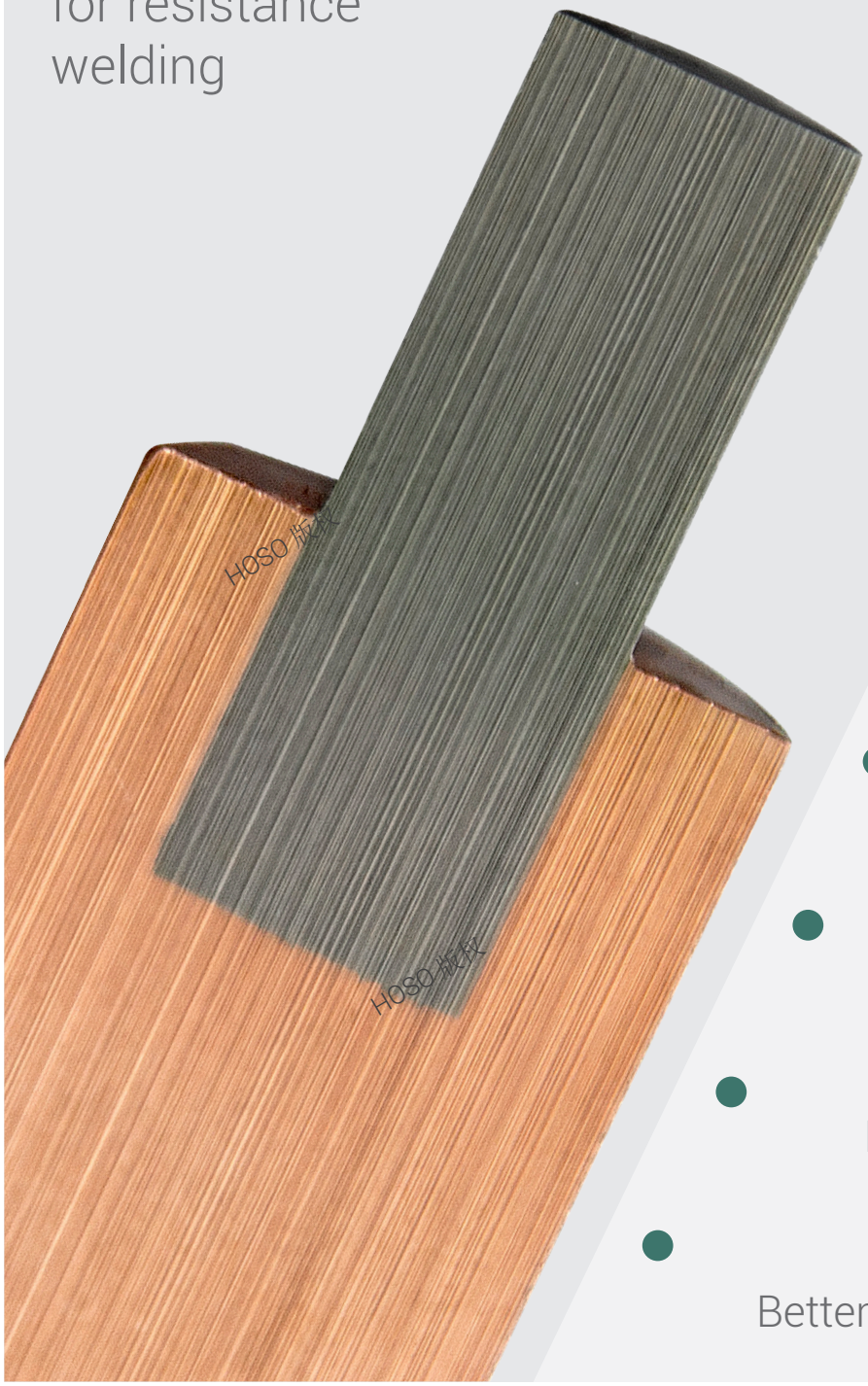
背铸式电极

焊接电极的创新性设计

Back-Cast electrodes

Innovative solution
for resistance
welding



- 品质优良
  The best quality
- 更长使用寿命
  Greater durability
- 更高使用效率
  Improved efficiency
- 更好的焊接稳定性
  Better stability of welding

背铸法技术
是电极制造的创新型技术!

Innovative BACK-CAST technology for the most demanding users!

背铸法电极

焊头跟电极杆之间有更好的结合。因此这种电极相比传统的钎焊结合方式的电极具有更好的导电率以及热导率，因此电极的使用寿命更长。钨的钎焊是一种很难的技术，设计到焊料的选择，焊接温度的控制等，通常钎焊的钨铜电极有空洞存在几乎是一定存在的。钨跟铜之间的孔洞阻隔了热能的传导，焊接电流的传输，从而带来电极使用寿命不长，焊接良率不高的问题。

Back-Cast sintered electrodes

The better the connection between the shank and the electrode tip, the better and more reproducible welding results and the longer life of the electrode. The quality of the connection in a standard soldered electrode is not ideal. The structure of the filler causes unstable resistance at the connection of the tip and shank, which adversely affects the electrode's performance and cooling performance, leading to reduced electrode life.

背铸电极 / Back-Cast electrode

钎焊电极 / Soldered electrode

创新性的背铸电极制作过程中在接合面使用特殊粉末在真空高温下钨跟铜之间形成过渡层。因此在微观下钨铜晶粒组织相互渗透，从而做到无缝结合。而在钎焊工艺中，钎料起到类似于“粘合剂”的作用，钎料作用于组织之间的驱动能不够，因此焊接好的电极在常温下看似无孔无缝隙，但在使用一段时间之后高温累积，结合面开始脱焊。同时钎料电阻的存在大大降低了电极对电流的传输能力。同等条件下，意味着焊接电流需要加大才能满足焊接熔核的产生条件。　我公司的背铸电极克服了以上缺点，钨跟铜的接合面无孔无缝隙，大大增加了电极的导热能力以及电导能力。

The innovative Back-Cast technology consists in the instertion of a metallic powder between the shank and the tip, which in the sintering process in the vacuum chamber passes through to the material structure. The homogeneous connection is free of cavities, voids and contaminations. The lack of an additional filler increases the temperature resistance of the electrodes up to the value equal to the melting point of copper, i.e. 1083°C, and significantly improves the ability of the electrode to dissipate heat. Back-Cast electrodes are best suited for automatic high-speed welding stations.

电极特性 / Electrode properties

特性 PROPERTIES / 材料 MATERIAL	铜 COPPER	铬锆铜 CuCrZr	钨 TUNGSTEN	钼 MOLYBDENUM	钨铜钎焊 STANDARD	钨铜背铸 BACK-CAST	钨铜背铸（2） BACK-CAST
硬度 Hardness and durability	★	★★	★★★★	★★★★	★★★★	★★★★★	★★★★★
抗烧损性 Low tendency to erosion and adhesion	★	★★	★★★	★★★	★★★	★★★	★★★
抗热传导 Thermal resistance	★	★★	★★★★★	★★★★★	★★★	★★★★	★★★★★
热导系数 Thermal conductivity	★★★★★	★★★★	★	★	★★	★★★	★★★
电导系数 Electrical conductivity	★★★★★	★★★★	★	★	★★	★★★	★★★
电极使用寿命 Electrode life	★	★	★★★★	★★★	★★★	★★★★★	★★★★★

背铸法电极的优势：

- 电极杆部跟电极头均匀结合
- 最高品质的电极
- 热导率相对恒定
- 稳定以及可重复性好
- 焊接能耗小
- 焊接参数稳定
- 自动焊接应用可靠

在某些特定的应用场景，环境和焊接参数下，背铸法的电极使用寿命是普通电极的10倍。

Advantages of the Back-Cast method:

- a homogeneous connection between the shank and the electrode tip,
- the highest quality of the electrode,
- invariable thermal conductivity,
- stable and repeatable electrode's resistance,
- less energy consumption in the welding process,
- stable welding parameters,
- reliability and "measurability" in automated processes.

The Back-Cast electrodes, depending on the application, conditions and welding parameters, can work up to **10 times longer** than standard electrodes.

电极 Electrode

硬度 / Hardness

耐用性 / Durability

热导率 / Thermal conductivity

抗热震性 / Thermal resistance

电导率 / Electrical conductivity

抗粘性 / Low adhesion

快速冷却 / Faster cooling

品质 / quality

电极寿命 / Longer life of electrode

焊接制程 Welding process

稳定性 / Stability

可重复性 / Reproducibility

性能 / Performance

产能 / Productivity

效能 / Economy

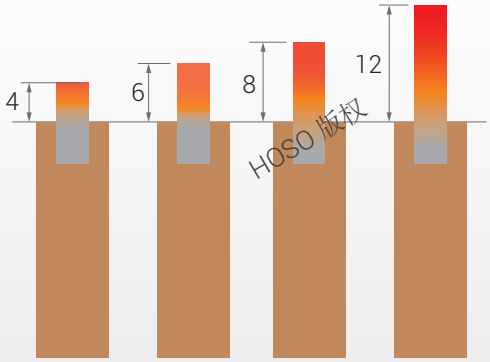
焊点质量 / Quality of welds

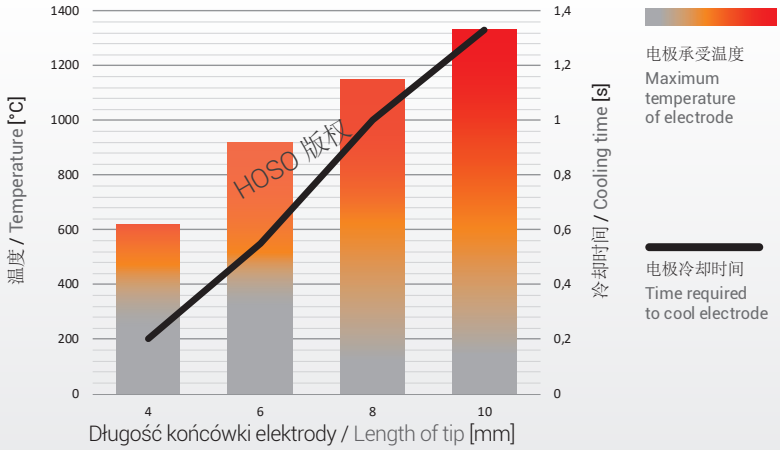
技术资讯
– 电阻焊接技术

1 焊头的长度跟热量的关系

电极头部的焊头尺寸越长，产生的热量就越多。考虑到金属材料性能影响最大的因素就是温度。 因此每个电极能够承受的温度是有限的。从另外一个角度说，电极温度越高就需要更长时间来降温。钨铜电极具有良好的热导能力 可以快速的降温以提升焊接流程的稳定性。

下图显示了焊头长度跟温度热能的关系图。同时揭示了焊头热量降到300摄氏度需要的时间。





焊头长度跟最大温升以及温降之间的关系 [mm]
The dependence of maximum temperature and cooling time on the length of the electrode tip [mm]

Useful information
– resistance welding technology

The length of the working part of the electrode and the amount of heat generated

As the length of the working tip of the electrode increases, the amount of heat generated increases and the maximum temperature that the electrode can reach, also it takes more time to cool electrode down. Very good thermal conductivity of tungsten-copper electrodes effectively speed up cooling, which contributes to the improvement of the welding process speed and its stability.

The graph shows the maximum temperatures that the electrode can reach depending on the length of the electrode tip. It also shows a time needed to cool the working part of the electrode to 300°C.

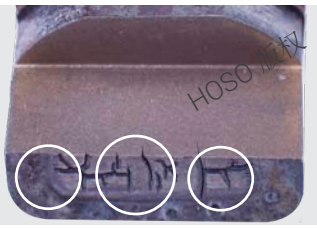
2 钨，钼的碎裂问题

随着使用次数增加钨磨损以及开裂风险增加。钨本质上来说有很高的硬度以及机械强度，但是它的缺点是高温冲击下容易碎裂。 钼以及TZM钼合金相比钨更加能够抗击高温下的压力冲击而不碎裂。 虽然相比钨来说硬度低的缺点会使得钼损耗加快并相对容易变形，但是考虑到它的高温抗冲击能力以及相对比较容易加工，在某些需要顶端部需要精细加工的应用以及焊接大面积铜编织线 以及 绞线的时候还是建议选择钼或者钼合金。

Crack resistance of tungsten and molybdenum

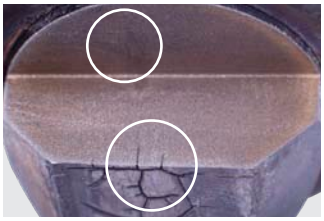
With the consumption of electrodes, the risk of cracking on the surface of the electrode increases. Tungsten is characterized by good hardness and mechanical strength at work in high temperatures, however, it is brittle and not very resistant to thermal shock, which can lead to the formation of micro scratches and cracks. Molybdenum and its TZM alloy are more resistant to thermal and mechanical shock and less susceptible to cracking during operation. Lower hardness at high temperature may cause faster deformation of the working part of the electrode and speed up wear of the electrode

焊头1
Electrode's head 1



内部开裂
Cracks in depth

焊头 2
Electrode's head 2



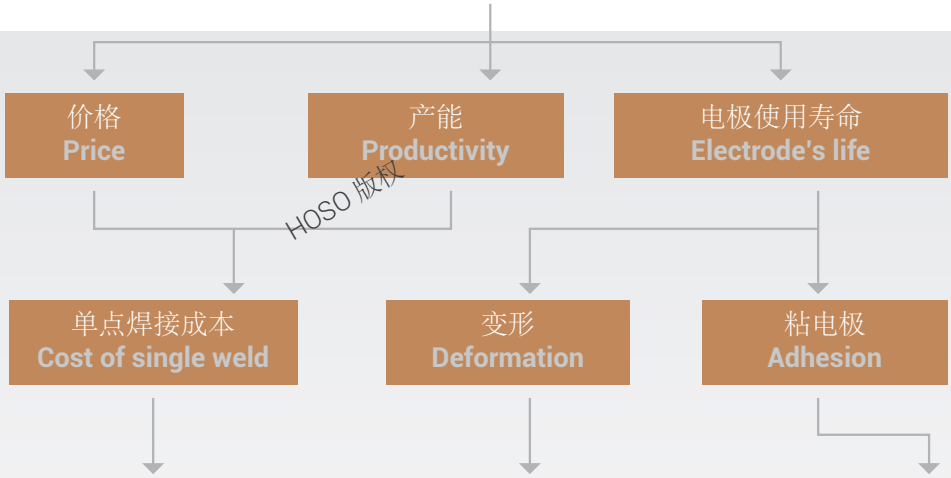
内部开裂
Cracks in depth

3 电阻焊接不良诊断
Causes of defects during resistance welding

不良瑕疵 / DEFECTS

操作员 OPERATOR	电极 ELECTRODE	机器 MACHINE	参数 PARAMETERS	焊接 WELDS
● 参数设定错误/ Bad parameter settings	● 材料质量差/ Poor material quality	● 降低电压/ Reduced voltage	● 焊接时间 / Welding time	● 焊接质量问题/ Bad quality
● 定位错误 / Bad material position	● 选错电极材料 / Bad choice of material	● 驱动出错 / Driver error	● 压力 / Pressure	● 脏化 / Dirt
● 使用环境恶劣 / Bad condition of electrodes	● 水冷设计问题 / Inappropriate cooling	● 电流加载错误/ Failure of the current system	● 电流/ Electric current	● 尺寸或均匀性不好 / Lack of uniformity in size and shape
● 参数设定不同 / Differences in parameters settings	● 电极形状设计有问题/ Inappropriate shape or size	● 压力系统出错 / Failure of the pressing system	● 点焊周期/ Number of work cycles of electrode	
	● 电极杆部与焊头结合有问题/ Poor bonding with the shank			
	● 电极加工精度不够 / Low precision of making electrodes			

4 如何选择电极
Analysis of the correct selection of electrodes



通过使用钨，钼焊头并且是用背铸法的电极，以增加制程稳定性以及电极的耐用性，减小能耗，增加产品一致性以及降低制程成本。

Increased stability of process and durability of electrodes by using Back-Cast electrodes made of Mo or W. Reduced power energy consumption, reduced production gaps and process cost.

用钨，钼，钨铜，银钨做的电极展示了更好的硬度以及高温性能

The use of electrodes made of W, Mo, TZM, CuW or AgW, which exhibits better hardness at high temperatures.

钨，钼以及含有钨钼的材料做电极比合金类的电极有更好的抗粘性

The use of electrodes made of W, Mo or materials containing them, which have a lower tendency to form alloys with the welded material.

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